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Presidential Address.

THE MOVEMENT FOR CLOSER APPLICATION OF SCIENCE TO INDUSTRIES.

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The subject taken for to-night's address is one very much before scientific workers at the present time, the movement for the closer application of Science to Industries being a very widespread one throughout not only the British Empire and the domains of its allies, but also more or less throughout all other countries of the globe. It is one of the most notable results of the great war which has afflicted the world for now nearly four years, and arises from the wider recognition by the nations of the urgent need of using to the full all the resources of science to improve industrial production.

This need has always been well recognised by the leaders of thought in all classes of the community, but the demands of the war seem at last to have brought it better home to the public in general that science is not a mere unintelligible pursuit confined to a few learned persons, but a real aid to and necessity of industrial progress. For this recognition we owe more than a little to the enemy, who have long vaunted in the most arrogant manner their alleged claims to superiority in scientific attainment, and have attempted to demonstrate it in the war by using poisonous gases, flame-throwers, and all sorts of other devilish contrivances to win their way to victory, not omitting to debase even psychology to the vile uses of their doctrine of "frightfulness." To meet their novel

methods of attack we have had to call more and more upon the aid of our own and our allies' men of science, to devise means of counteracting their evil devices, and to pay them back in their own coin with interest. This has brought it home to even the most unthinking "man in the street" that we should be lost if our men of science were not able to reply to the devices of the enemy. It has come upon the bulk of the community also as a great shock that in many lines of industrial production the British nations had become dependent on foreign and even upon now hostile countries for materials and manufactures of necessaries of existence, and were unable to obtain their supplies as hitherto, and it has been well impressed upon them that the only hope of recovering our position is by invoking the aid of science to enable us to become again self-supporting and self-defensive. The war has caused a revision of many old ideas as to freedom of trade and the gospel, beloved by economists, of buying in the cheapest and selling in the dearest markets, and we have had to recognise that defence of the national existence is a matter of more consequence than any merely trading considerations. We see now that whatever else we do, we shall have to provide for all necessities for defence and subsistence out of resources under our own control, with the least possible reliance for them upon other people with whom our relations may become hostile. This is very particularly the case with Australia, for the war has brought us face to face with the fact that if we had to depend upon our own resources Australia is hopelessly unprepared to meet a powerful enemy, especially if that enemy be a maritime Power which could cut us off from sea communication with the outside world. Our means of making munitions of war are utterly inadequate to cope with a war demand, and many war necessities we are not in a position to make at all. It is obvious, therefore, that Australia must not be content to remain merely a producer and exporter of primary products, but must institute manufacturing industries, even at much pecuniary sacrifice, which will enable us to provide fully for our own defence in case of necessity. No sooner do we look round to see how such manufactures may be started than we begin to appreciate the fundamental position occupied by science in regard to them, and the absolute necessity of co-ordinating all the resources of science and industry to bring about success.

On the outbreak of war there was immediately great enthusiasm on the part of all classes of the community to take some part in making good our national deficiencies; but with all the good will in the world many of these efforts have been very ineffective for want of good direction and systematic organisation. There has been much duplication and overlapping of effort, various sporadically formed bodies all trying to do the same things. They are like the crowd at a house on fire, all willing and anxious to do what each man can do to help, but lacking in combination and effecting little

in consequence. When the fire brigade arrives the position changes at once, order taking the place of chaos, and systematic and directed work that of undisciplined endeavour. Quite the same course must be followed if we are to make the best use of the energies directed towards establishment of industries: the various detached efforts must be brought together into more effective combinations and under more uniform control. It is not to be denied that some amount of competition and rivalry among the various workers on the same lines is often of much value in producing the best effects, just as the friendly rivalry of different fire brigades may be of much advantage at a big conflagration, but the main thing is that the whole of the work should be organised and systematised to the one end, and that there should be a minimum amount of duplication of work.

It will be useful to review briefly the steps which are being taken in the British Empire to co-ordinate science and industry, and to discuss somewhat more fully the position in the same regard of Australia in general and our own State more particularly.

Throughout the world there are a great number of organisations more or less connected with science and industry, comprising Government departments, universities, technological colleges, scientific institutes for research, and a vast number of societies, associations, and similar bodies covering almost every department of the subject from pure science to pure trade, and including men whose specialities lie upon educational, investigational, professional, technical, and manufacturing lines. There are also very many private firms and private persons who maintain laboratories and workshops in which much investigation and experimentation are carried on. All have their own special spheres of operation, and apply science to industry in a greater or less degree, and each is liable to have special information and experience upon certain aspects of operations in which several are more or less concerned. The great object of organisation is to bring together from all these sources all the knowledge that can be concentrated upon any particular industrial problem. This method has been happily referred to as one of "massed attack," and has given valuable results in many different lines already.

Recognising the necessity of organising the national forces in this way, and that such organisation would require to be in the very closest touch with the Government itself, the Imperial Government appointed a Committee of the Privy Council "for the organisation and development of Industrial Research," consisting of certain members of the Privy Council, who were themselves of distinguished scientific attainments, assisted by an advisory council of men eminent in science and industry. It will be seen that this committee was an actual part of the Government itself, and so in the inmost councils of the nation, giving it a standing and authority much

higher than that of any merely departmentally organised body. The advisory council might really be responsible for any action recommended, but before it could be adopted by the Government the council would have to convince the Committee of the Privy Council that its recommendations should be endorsed by the Government. Some stress is being laid on this point of the constitution of the Imperial scheme, as it appears to me to be one of the most vital importance, and which should form a characteristic feature of any like scheme instituted elsewhere in the Empire. Such a work requires the authority and the purse of the nation as a whole behind it, and its direction should undoubtedly be regarded as a proper Government function, in the interest of the whole community.

It was soon found that the work of the Committee of the Privy Council and its Advisory Council required establishment of a special "Department of Scientific and Industrial Research," and the foundation of this department led to the creation of a body corporate, under the name of "The Imperial Trust for the Encouragement of Scientific and Industrial Research," to have control of the expenditure of the fund of one million pounds sterling voted by Parliament for this object, such fund being expected to provide for the work for a period of five or six years. It was ascertained that it would not be possible to develop systematic research in several industries unless the Government were prepared to assist financially for an agreed term of years, but it is expected that the industries, and especially the great staple manufacturing industries of Great Britain, will bear a considerable share of the large expenditure involved, and some of them might find themselves able to carry on the work without Government assistance once it was well started. To this end the Department of Research is encouraging and inviting the formation among suitable industries and groups of industries of Association for Research, estab'ished under the Companies Act, but limited by guarantees and debarred from taking any profits. These Associations of manufacturers and persons concerned in the various industries are a very vital and valuable part of the British scheme, and should be very effective in providing not only funds for research, but also the best of opportunities and facilities for investigators, and the best means of bringing the latter into most intimate connection with the practical problems of manufactures. Associations for research are being, or have been formed in the cotton industry, among the woollen and worsted manufacturers, in the Scottish shale oil industry, and among photographic manufacturers, while many other industries are reported to be considering the formation of like associations, primarily for the purpose of working out problems arising in the practice of their particular industries.

In another direction where national control is requisite, the Department of Research is acting somewhat more directly, having

taken over the control and responsibility of the National Physical Laboratory from the Royal Society, thus relieving this body from much financial anxiety. The Executive Committee of the Royal Society, however, continues to have the management of the work of the Laboratory as a committee under the department. It is believed that this course "will help to bring fundamental research into closer and more continuous relation with the investigations into processes and products which must occupy so large a part of the attention of the works research laboratory."

A Special Fuel Research Board has been constituted to deal with the problem of Fuel Economy, and a grant of £1,000 a year for five years with £750 special grant for apparatus has been made to the Department of Technical Optics recently established at the Imperial College of Science and Technology, which on its part is providing laboratory accommodation and a grant of £2,000 for equipment. This department is also getting generous support from the Board of Education, London County Council, and the Optical Industry.

Up to the end of the financial year 1916-17 the Department of Research had considered and approved recommendations in aid of forty-four scientific investigations of industrial importance.

The report of the Advisory Council for the same year urges the vital need of research at the Universities, especially in pure science, and their belief that co-operation is necessary between capital, management, science, and labour "as the best means of financing and directing the extended laboratory investigations and large-scale experimentation required for industrial research." They have addressed themselves in the main to the organisation of industrial research, feeling the "paramount importance of arousing and securing the interest of manufacturers in the application of science to industry," bearing in mind at the same time Sir Joseph Thomson's aphorism that "pure science is the seed of applied science."

In Australia a like movement to that in Great Britain was soon set on foot, but for some time it was confined mainly to making a survey of the field of work to be entered upon, in order to see on what lines it would be best to make the attack. For this purpose an Advisory Council was appointed in March, 1916, and now comprises 35 members representing all the States of the Commonwealth of Australia. It was apparently intended to be a more or less temporary body, to prepare the way for a permanent Institute of Science and Industry, the establishment of which is now expected to be completed very shortly.

The chief functions of the Advisory Council are (1) "to consider and initiate scientific researches in connection with or for the

production of primary or secondary industries in the Commonwealth, and (2) the collection of industrial scientific information and the formation of a bureau for its dissemination amongst those engaged in industry."

Owing to the difficulty of getting the whole Council to meet together, general meetings of the whole body have been few, and the work of the Council is carried out mainly by an Executive Committee sitting in Melbourne, and State Committees meeting in each State of the Commonwealth. With the intention of preserving the necessary close touch between the Executive Committee and the Government, the Prime Minister, or in his absence the Vice-President of the Executive Council, is chairman of the Executive Committee, but it is to be regretted that stress of public business necessarily makes it somewhat uncommon for either to take an active part in the operations of the Committee. The arrangement therefore does not seem to promise quite such complete mutual understanding between the Federal Government and the Committee as is provided by the British system of direct control of the Department of Scientific and Industrial Research by a Committee of the Privy Council. It is expected, however, that in the proposals shortly to be laid before the Federal Parliament, this will be remedied by forming a Department of Science and Industry in close connection with a wider one of Commerce and Industry.

The Chairmen of the State Committees become *ex officio* members of the Executive Committee, and by receiving minutes of its proceedings and copies of all information supplied to it are enabled to keep in touch with the work of the central body and form a link between it and the State Committees.

The State Committees are formed of all the members of the Advisory Council resident in the State, together with associate members representative of particular branches of science and industry. The associate members are usually nominated by the State Committees, and appointed by the Federal Government, but are not members of the Advisory Council. The State Committees consider matters arising within and especially affecting their own States, and report thereon to the Executive Council, which then decides as to any executive action and authorises such expenditure as may seem to it to be necessary.

In order to enlist the co-operation of specialists in any subject under consideration, Special Committees may also be appointed by the Executive to study and report upon special problems. These should be the main working committees of persons with special knowledge of the matters taken up. They may be appointed directly by the Executive Committee of their own initiative, or more usually are invited by the State Committees to deal with par-

ticular propositions and appointed by the Executive Committee on their recommendation.

Up to 30th June, 1917, there had been appointed 20 special committees, and grants had been authorised to them for necessary expenses of £3,435. The list of these committees will give a good idea of the nature of the subjects with which they deal:—

1. Chemicals.
2. Ferro-alloys.
3. Standardisation of design of scientific apparatus.
4. Mode of occurrence of gold in quartz.
5. Tick pest.
6. Alunite.
7. Yeast and bread making.
8. Nodule disease in cattle.
9. Marine Biological Economics of Tropical Australia.
10. Damage by insects to grain in store.
11. Electrical sterilisation of milk.
12. Tanning properties of Queensland mangroves.
13. Tanning properties of red gum in Western Australia.
14. Means of transmission of worm nodule parasite.
15. Control of sparrow pest.
16. Alcohol fuel and engines.
17. Classification of imports of chemicals.
18. Tanning methods of New South Wales.
19. Posidonia fibre.
20. Grass-tree.

In a later list up to April, 1918, the number of Special Committees has been increased to 27, and some of them of which the work is of a permanent or prolonged nature have been established as standing committees.

From this list of subjects it will be seen at once that it has been specially intended to take up subjects of particularly Australian interest and value, and that primary production and industries immediately springing therefrom have had more attention than the more advanced industrial processes. Many of the problems taken up, such as those relating to pests, require much co-operation of practical producers, scientific investigators, and Government authority.

One great aim of all Special Committees should be to find out and enlist the active sympathy and co-operation of all active workers in the particular field to be investigated, so as to get combined effort with the minimum of duplication and overlapping. Massed attack is the object, not individual sniping.

The investigations on cattle-tick pest and beef-nodule worm, eradication of prickly pear, cotton growing, tanning materials,

power alcohol, sources of potash, pottery materials, and several other matters, have already resulted in the publication of bulletins, but these mostly are of a more or less preliminary character, giving statements of the position as regards each problem and narrating the steps taken already and regarded as necessary to attack it, but in most instances still leaving the main bulk of the experimental and investigational work to be done by people able to devote their whole time and energies to it in properly equipped laboratories and also on a practical working scale outside.

The Advisory Council has as one of its functions the establishment of a bureau for the collection of industrial scientific information and its dissemination, and has been preparing a catalogue of scientific periodicals available in Australia and numerous abstracts of information on a large number of subjects about which such is desired by Special Committees and other investigators.

It will be seen that the Australian movement is not yet quite so far advanced as that in Great Britain, having had to spend more time over arrangement of preliminary work, and not being in a strong financial position. In Great Britain, a large manufacturing country, the investigations immediately required relate very largely to improvements in methods and processes of established industries, and have the support of many interested manufacturers, willing to assist with money and workshop facilities. In Australia the problems are considerably different, as they relate more particularly to development and improvement of the primary industries, and foundation upon them of derived secondary ones, many of which are at present quite new to this country. Investigations of opportunities for starting industries yet untried here, but well known elsewhere, are as important as those dealing with new processes and discoveries. We have not the benefit, as in Great Britain, of assistance from a large body of wealthy and interested manufacturers ready to assist in such investigations, and in consequence a much larger share of the financial burden of the work falls upon the community as a whole, through its Government. Even in Great Britain it is found that there are many necessary investigations of which the immediate bearing upon their interests is not so apparent as to claim support from manufacturers, and which have therefore to be supported from the public funds. The Advisory Committee refer to some of these in their 1916-17 report, as fields of research of wide and general importance affecting almost all industries and people and therefore best to be dealt with directly by the Department of Research, and financed from its funds.

The scheme of action outlined by the Prime Minister of the Commonwealth at a conference in Melbourne at end of February last and likely to be adopted more or less completely by Parliament very shortly, contemplates the formation of a Department of Com-

merce and Industry, under a Minister for Commerce and Industry, which will organise commerce and industry generally, so far as it can. Industrial Associations formed by the producers in each industry or group of allied industries will form the units of the scheme of organisation within the Commonwealth. Each association will have its council, dealing with the conditions of the particular industry, and representatives from these councils will form a General Council of Science and Industry. "The functions of the general council will be both advisory and executory. It will co-ordinate the activities of the various associations, give the support of its authority and influence to proposals put forward by them for developing trade, opening up new opportunities, improving methods of production, securing financial assistance, protecting local interests, recommending necessary legislation—for example, tariff or bonus—or whatever may be deemed desirable for the protection and expansion of industry. Just as the association will be the mouthpiece and executive of an individual industry, so the general council will be the mouthpiece and representative of commerce and industry in general. . . . The Government proposes to place the Science Bureau upon a permanent basis, appoint first-class men of high qualifications in charge, and give it such financial backing as is necessary to ensure its success. The Science Bureau will be an integral part of the scheme of organisation. It will be in direct touch with the Department of Commerce and Industry and with the General Council and various associations formed under the scheme. Through it we will link up the technical schools and colleges, and through them the Universities and general schools." The appointments have been recently announced of a Director of Commerce and Industry and a Director of Science and Industry under this scheme.

Up to the present time the work under the Advisory Council of Science and Industry has been mainly carried on by the voluntary services of the members of the various committees formed under it, although salaried investigators have been employed in a few instances. This system has some great merits and some very serious weaknesses, the principal merit being the calling out of the best voluntary services of a great number of the scientific workers who are always ready to give of their best for the public good, and who will do so most generously and freely under a voluntary system, while great weaknesses are that such voluntary work is necessarily limited to the time which busy men can spare for it from their everyday absorbing duties, and that there is apt to be a great lack of co-ordination of effort due to absence of a firm governing authority. Undoubtedly the very high value of the voluntary and unpaid work must be recognised, especially as it often follows lines of investigation which otherwise would probably be passed over, but to carry out systematic series of investigations it is soon obvious that men have to be employed to give their whole time to the work if results

are to be looked for within any reasonable time. The work is of the most absorbing character and requires all the time and energies of the investigators, often requiring continuous observations over periods of time so long as to make serious demands upon their physical strength. On the other hand, any scheme which disregards the help of the voluntary worker and depends entirely upon a salaried staff is apt to become purely a departmental one, and to lose the valuable stimulus of exchange of ideas and suggestions between the salaried men and the voluntary workers. Purely departmental effort is apt to get into grooves, and may very easily get completely out of touch and sympathy with much work being done on more or less parallel lines by independent workers. It seems to me that the usefulness of the Imperial Institute, an organisation primarily intended to take up much the same sort of work as is now to be taken in hand by the Councils of Science and Industry, has suffered very markedly from exaltation of the departmental aspect and losing touch with the body of active outside workers.

The most desirable combination appears to be one in which the paid investigators are to a considerable extent responsible, not merely to their immediate departmental heads, but also to the public opinion of the body of more or less trained workers on the particular matters undertaken. These should have opportunities of ascertaining the nature of the work being done, and should be encouraged to make suggestions, and to carry on additional investigations on their own account. They should have opportunities of discussing the reports of the investigators before these are finally given to the world, and be invited to express their opinions upon the results. In most investigations of the class to be undertaken, the general public is not competent to judge the value of the work done, and has to depend upon the opinion of it formed by a few of its members better qualified to appreciate such work. If these are satisfied with the results obtained, the public in general can follow them with much confidence. There are advantages therefore in a system which ensures that the investigations carried on shall be made under a certain amount of supervision and discussion by committees of persons whose training and interests enable them to understand and appreciate the work done. This would be quite in keeping with the traditional practice of the British people, whose genius has long seized the cardinal principle of entrusting direction of its activities to the most capable persons in each branch of public work, selected by choice of the limited section of the whole people best able to judge in the particular case.

It would appear therefore that the lines of the proposed Commonwealth scheme, aiming to obtain the co-operation of all workers in any branch of industry, are well devised, and preferable to any

proposition which would relegate the volunteer assistants to a place of no importance, quite outside of a purely departmental administration. The advisory councils and committees should be live bodies, with much direct control over the lines of investigation to be followed. Close co-operation in this way of the salaried and unpaid workers will result in very much more general interest being taken in the work being done, and in far more widespread appreciation of it by the general public. It appears to me that much stress should be laid upon this aspect of the matter and every effort made to popularise knowledge of the scientific work done, to interest and obtain the active co-operation of as many voluntary workers as can be got together, and to avoid relying too much upon purely departmental organisations.

In other parts of the Empire very similar action is being taken to that in Australia in formation of organisations for the progress of industry under the guidance of science. New Zealand has formed an Industrial Efficiency Board, a name which suggests a departmental rather than a popularly constituted organisation; Canada has formed a Committee of Council for Scientific and Industrial Research; South Africa and Rhodesia have Scientific and Technical Committees; and the Government of India has directly undertaken a special investigation upon the dyeing of tussore silk. From such little information as I have been able to obtain it would seem that these bodies are mostly proceeding in much the same way as the Australian Advisory Council, first by taking stock of the field of endeavour and then by investigating problems of especial interest to their own people and organising means of combined effort of interested parties to develop industries.

Both in Great Britain and the United States of America much help is being given to the Governments by many of the great scientific and professional societies, such as the Royal Society, the Institution of Mining and Metallurgy, the Institutions of Civil, Mining, Mechanical, and Electrical Engineers, the Chemical Societies, and many others. Indeed it may be said that practically all such bodies have placed their best services at the call of the Governments for any use which may be made of them, and much very useful work has been done by them. They are formed of the specialists in the community in their particular domains who are best able to advise the people as a whole on questions relating to these domains.

Returning to the Australian position, the particular needs of each State are not in all cases satisfied by the steps which have been taken by the Federal Government, and some of the States themselves have undertaken more or less work in aid of the development of their own particular industries. Our own State of Western Australia has formed a Department of Industries under a Minister of Industries, which is striving to institute new industries suitable for

the resources of this State without waiting for the Federal organisations to take action. There is no reason for any clashing of authority or duplication of effort through the State taking such action, as it should be possible for both State and Federal organisations to work quite well and harmoniously together with much mutual advantage. In many industries it will be of very great advantage to have the State authority working in the interests of its own State, as the more general Federal one may not be impressed with the necessity of moving in many matters which the more local State one can see are most important for its own case. Other States also have found it advantageous to use the resources of their public departments and State authority to facilitate development of industries in which such States are particularly interested, and in the great centres many even more local organisations have been formed among the people most concerned, *e.g.*, the Institute of Victorian Industries, and our own small League for the Promotion of Industries. The last-named body is of interest to the present audience because the Royal Society of Western Australia accepted an invitation to become one of the members of it. Its aim is to link together all the more or less public bodies interested in the many various aspects of the development of industries, so as to make use of the services of any persons who can contribute special knowledge towards the solution of any particular project. It is also notable as a local example of the practical difficulty of focussing such energies upon any one immediate object, for no sooner is a suitable industry suggested to be started than the need arises for some person or party to take it up in a commercial manner, and the need of considerable funds becomes at once an urgent one. No progress is possible without a good deal of expenditure. Such a body as this league can suggest openings for industries and investigate many matters of great importance to those starting them, but someone else has then to undertake the actual venture. The greatest usefulness of such a body would really be at a somewhat later stage, when the persons who have undertaken an industry find that they want advice on points in the special provinces of the various societies composing the League, which could then assist them very considerably by investigations and advice. The aims of this League and of Departments of Industry need not necessarily require any new researches or solution of scientific problems, the establishment of quite a humble industry like manufacture of glue or blacking being quite as much within their province as ventures of a more ambitious type. There are numbers of little industries which are very much required, and which ought to be undertaken, which do not require immediately any special help from science.

The little local example of the Society for the Promotion of Industries is more or less typical of the efforts being made throughout the whole field of industrial endeavour which it is the aim of

the greater movement under review to cover. There is an advisory and investigational side to them all, for which the voluntary services of a large body of willing helpers are available, and there is a practical commercial side which necessitates capital and business ability for starting the actual industries. For this latter side both the British and Australian schemes rightly rely very greatly upon the associations of manufacturers and producers to carry projects into practical effect. These comprise the people who understand the business aspect of the matter, and who are able and willing to spend money to start commercial industrial propositions when a sufficient inducement seems to be before them. It is the function of the advisory side to survey the field as thoroughly as possible and get together all the information of use to those actually engaging in the industry and to make investigations to remove difficulties and solve problems. Then when an industry has actually been started, its operators should be able to get the help of the advisory side in coping with the many difficulties which are sure to arise. In this phase of the matter the policy adopted by the Mellon Institute in the United States seems an admirable one to follow. They send advanced students to various industrial factories to learn all they can of the practical working of the business and get a knowledge of its problems. After a time these students return to the Institute for further training and to carry out special researches on the problems encountered in practice, and then go back into the factories to carry on like work there under business conditions. With a like purpose the British Advisory Committee suggests attaching young research workers to the laboratories of various manufacturing works for an agreed length of time, which might be divided into three periods. During the first period the department would pay the salary of the worker, during the second the department would pay half, and during the third the firm would pay the whole. It is expected that in this way the technical direction of industries in time will fall very largely into the hands of men who themselves have had a scientific training, or at least have been accustomed to work in close connection with a scientific staff, and that the influence of scientific methods will thus become more and more increasingly felt throughout the industries.

It will be seen that the whole movement has become dominated by its industrial aspect, the great object being to bring the resources of science to bear in assisting industrial development with a view to very immediate results. To a very great extent this is highly desirable, and to many business men it may seem that it is the only side of the question which is worth considering, but there is some reason to be afraid that in the desire for immediate results it may be overlooked that these cannot be obtained without much research work, the objects of which are not intelligible to the uninitiated. The public are apt to expect too much of their scientific advisers

through thinking that they ought to know already all about very many things which still require much investigation, and they are therefore liable to be very impatient at delays of which they do not understand the reasons. The scientific advisers are then told that they are wasting time over things of no value to anybody, and only of scientific interest, the ignorance of the critic of all knowledge of the matter being no bar whatever to his having an ineradicable conceit in his own ability to form a judgment. It is very hard to convince such persons that there are no royal roads to scientific achievement, and that the way to success is through incessant attention to minutiæ of which the importance may not be appreciable at first even to the investigator himself. The importance of research work and progress in pure science must not be allowed to be lost sight of in the desire for immediate utility as a direct outcome of the investigations, and the community must be trained to recognise that much time and money may have to be expended on scientific researches before practical results can be looked for. Some such idea as this appears to have been in the minds of the British Committee of the Privy Council for Scientific and Industrial Research when they concluded their 1916-17 report with expression of a belief that the work of the Advisory Council "will help to achieve that revolution in the attitude of your Majesty's subjects towards scientific thinking, without which no expenditure of money on industrial research, however lavish, will avail." The general public have to be educated to a reasonable appreciation of scientific work and its methods, to have some understanding of its capabilities and its limitations, and to learn that scientific knowledge of the principles underlying industrial operations is just as necessary to industrial operators as is understanding of trigonometry to those of a land surveyor.

In its earlier endeavours the Australian Advisory Council of Science and Industry may appear to some people to have confined its work rather too much to the scientific side of the subjects taken up to the detriment of more practical issues, but closer acquaintance with the work done soon shows that no reproach of this sort is fairly applicable. As scientific men the Council have had a better understanding than most of their critics of the sort of researches necessary before practical issues can emerge from them, and have set about the problems before them on lines which give good promise of ultimate success.

Our survey of the movement under notice has brought out the very general desire for co-ordination of effort and prevention of unnecessary overlapping of investigation. It also raises important practical questions as to the delimitation of the spheres of action of the various bodies which have been organised in order to get the best results. How far, for example, should the Australian re-

searches avoid the subjects taken up by the British investigators, or the State Department's efforts be under control or direction from a Central Commonwealth authority? It seems to me that we must avoid making a fetish of centralisation and co-ordination, and remember the cardinal importance of individual initiative in both scientific investigations and those relating to practical industrial activities. There should be no checking of Australian investigation of timber problems because the same ground is being gone over in Canada, nor should any impediment be placed in the way of West Australian researches into the pottery clays of this State because some other body of workers is engaged with the same subject in New South Wales. The old adage is very true that when one wants a thing well done one must do it oneself, and there are many matters which may appear to be of small concern to a central authority which are highly important to local bodies and persons. If we desire to find a use and a market for, say, Xanthorrhea resin (Blackboy Gum) because the raw material is very plentiful and cheaply obtainable in this State, we are more likely to succeed in doing so if we investigate locally where the importance of the quest is understood than if we send to an authority at, say, the Imperial Institute, to whom it is of little interest whether supplies of material for the British markets come from Western Australia or Winnipeg. His interest naturally is in getting fitting material for the use of British manufacturers wherever he can get it to best advantage, while ours is to get our particular local article brought into notice and use. It is evident that the individual and local efforts for starting particular industries in particular places must in the end be the principal means by which any commercial results are reached, and that the whole systematisation of research should be to the end, not of accumulating knowledge at a central source, but in spreading it so that it finally results in individual performance. The great end should be to make it as easy as possible for the man who begins and carries on an industry to know everything that will help him to work to the best advantage, and to obtain the assistance of the most capable scientific investigators, whether they are near to him or at the other end of the Empire.

Perth, 30th May, 1918.